Workplan and Analysis of Brownfields Cleanup Alternatives
Mr. A's Dry Cleaners

Twin Falls, Idaho

Prepared for:

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List of Acronyms and Abbreviations

µg/L	Microgram per Liter
$\mu g/ft^2$	Microgram per square foot
ABCA	Analysis of Brownfield Cleanup Alternatives
bgs	Below Ground Surface
COC	Contaminant of Concern
ESA	Environmental Site Assessment
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDTLs	Initial Default Target Levels
LUST	Leaking underground storage tank
MCL	Maximum Contaminant Level
mg/kg	Milligram per Kilogram
mg/L	Milligram per Liter
OSHA	Occupational Safety and Health Administration
PCE	Tetrachloroethene
PRG	Preliminary Remedial Goals
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
SVOC	Semi-volatile Organic Compound
USEPA	United States Environmental Protection Agency
VCP	Voluntary Cleanup Program
VOC	Volatile Organic Compound

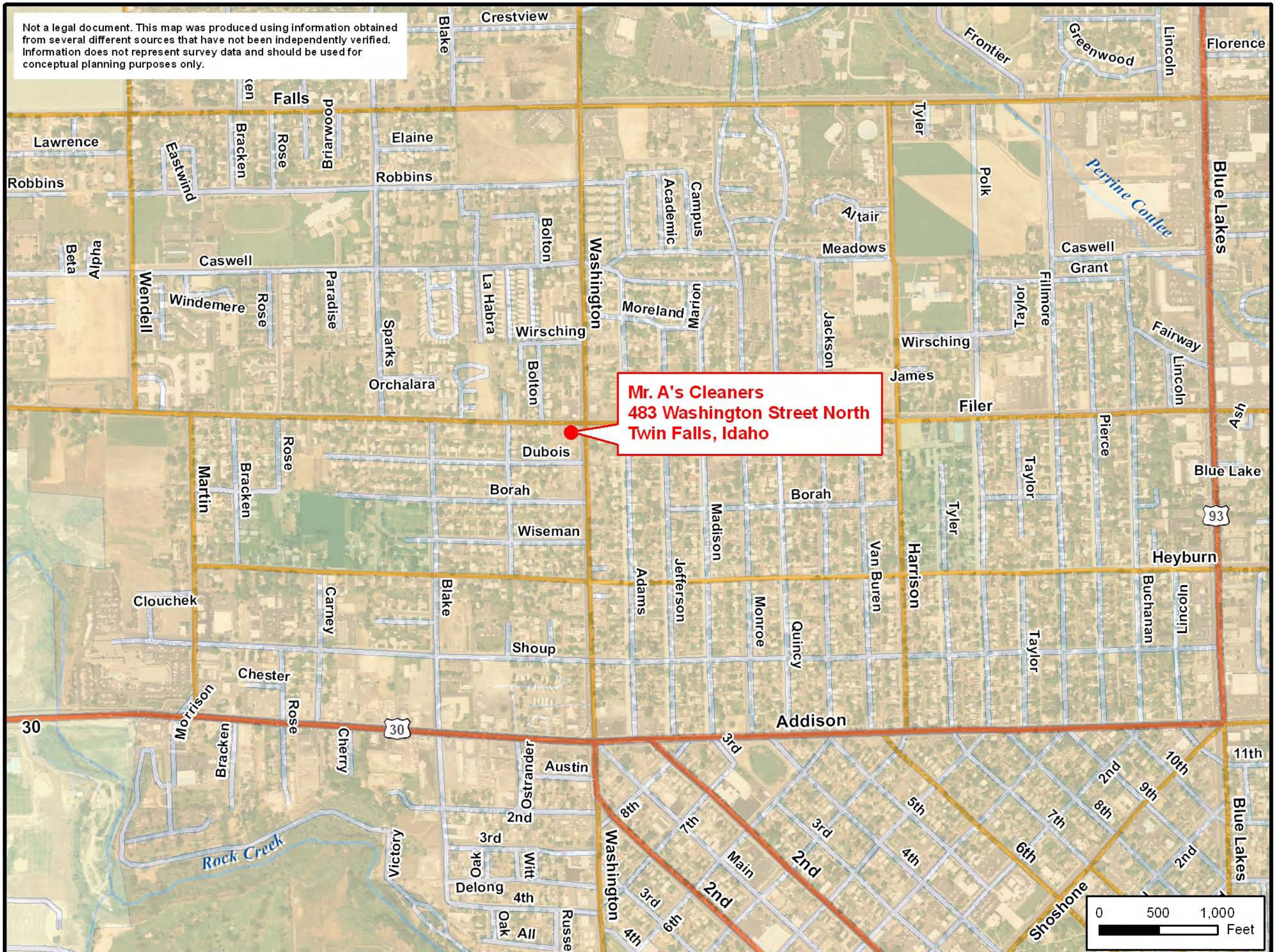
EXECUTIVE SUMMARY

TerraGraphics Environmental Engineering, Inc. (TerraGraphics) has developed this Workplan and Analysis of Brownfields Cleanup Alternatives (ABCA) for the former Mr. A's Dry Cleaners located at 483 Washington Street North in Twin Falls, Idaho (hereinafter referred to as the "site") for Luke Holdings, LLC. This Workplan and ABCA are required by the Idaho Department of Environmental Quality (IDEQ) Voluntary Cleanup Program (VCP) and are completed in accordance with the United States Environmental Protection Agency (USEPA) Brownfield Cleanup and Redevelopment Program Grant. In accordance with IDAPA 58.01.18, this voluntary remediation work plan submitted for IDEQ approval has identified the remediation standards to ensure that substantial present or probable future risk to human health or the environment is eliminated or reduced to protective levels based upon present and reasonably anticipated future uses of the site (IDAPA 58.01.18(02)b).

A site characterization of Mr. A's Dry Cleaners conducted in 2007 generated the following findings:

- Tetrachloroethene (also known as PERC or PCE) concentrations in soils from the site were found to exceed the Initial Default Target Levels (IDTLs);
- Groundwater samples downgradient of the site had PCE concentrations that exceeded IDTLs;
- Sub-slab vapor concentrations for PCE were found to range from 8,800 $\mu g/m^3$ to 360,000 $\mu g/m^3$; and
- Ambient air samples collected from the interior of the building exhibited PCE concentrations two orders of magnitude above the USEPA Region 9 preliminary remediation goal of 0.32 $\mu g/m^3$.

Subsequent to the 2007 characterization, the site owner (Arlo Luke, Luke Holdings, LLC.) entered into the IDEQ VCP. Seven remedial technologies were evaluated, and a combination of two technologies (soil vapor extraction and ozone sparge) has been determined to best meet the performance criteria to attain target cleanup levels identified for the site.



TerraGraphics Environmental Engineering, Inc.	File 07_PriestRiver/mracleaners	Requestor A. Parrish	Project Name Mr. A's Dry Cleaners
	Print Date April 25, 2007	Project Manager J. Munkers	
	Project Number 07014	Cartographer B. Bailey	

Figure 1

Site Location Map

SECTION 1.0 INTRODUCTION

TerraGraphics Environmental Engineering, Inc. (TerraGraphics) has developed this Workplan and Analysis of Brownfields Cleanup Alternatives (ABCA) for Mr. A's Dry Cleaners located at 483 Washington Street North in Twin Falls, Idaho (hereinafter referred to as the "site"). This Workplan is conducted according to Idaho Department of Environmental Quality (IDEQ) Voluntary Cleanup Program (VCP). The ABCA accompanying this work plan was completed in accordance with U.S. Environmental Protection Agency (EPA) brownfields cleanup revolving loan fund requirements.

1.1 Purpose

A 2007 site characterization generated the following findings:

- Tetrachloroethene (also known as PERC or PCE) concentrations in site soils exceed the Initial Default Target Levels (IDTLs);
- PCE concentrations in groundwater samples downgradient of the site exceed IDTLs;
- Sub-slab vapor PCE concentrations range from 8,800 $\mu g/m^3$ to 360,000 $\mu g/m^3$; and
- Ambient air samples collected from the interior of the building exhibited PCE concentrations two orders of magnitude above the USEPA Region 9 preliminary remediation goal of 0.32 $\mu g/m^3$.

Subsequent to the 2007 characterization, the site owner entered into the IDEQ VCP. IDEQ will provide regulatory oversight to ensure that cleanup activities are performed in accordance with Idaho State regulations. This Workplan has been prepared in accordance with the Idaho Administrative Procedures Act Idaho Land Remediation Rules (IDAPA 58.01.18) to evaluate and identify cleanup alternatives that will reduce risks to human health and the environment that are associated with PCE contaminated soils and groundwater at the site.

1.2 Scope

The scope of this report includes the identification, evaluation, and selection of cleanup technologies for contaminated soils and groundwater at the site. Specific tasks include:

- Review of previous reports and investigations;
- establishment of cleanup goals and objectives;
- development of cleanup alternatives in accordance with the site cleanup goals;
- description of criteria used to compare cleanup alternatives;
- selection of a preferred alternative and subsequent cleanup plan; and the
- development of a statement of work (including a timeline, deliverables, and cost estimate) for the preferred cleanup alternative.

1.3 Report Structure

Section 1 Introduction provides an overview and brief description of the purpose and scope of the Workplan.

Section 2 Background includes a brief site history, a discussion of the local and regional groundwater flow as it applies to the site, and a summary of prior environmental investigations at the site.

Section 3 Cleanup Objectives and Goals includes a discussion of the current and future land use, contaminants of concern, and identified cleanup objectives and goals for the site.

Section 4 Identification of Cleanup Alternatives identifies and describes proposed cleanup alternatives.

Section 5 Detailed Analysis of Alternatives describes the criteria used to evaluate the proposed alternatives. The cleanup alternatives described in Section 4 are evaluated using the criteria established in this section.

Section 6 Description of the Preferred Alternative identifies a preferred alternative, and provides a discussion describing the preferred alternative.

Section 7 Preferred Alternative Statement of Work describes the preferred alternative in detail, and provides a preliminary timeline, cost estimate, and requirements for the Health and Safety Plan.

Section 8 References provides references for reports cited in this document.

SECTION 2.0 BACKGROUND

2.1 Site Location and Description

Mr. A’s Dry Cleaners is a former dry cleaning operation located at 483 Washington Street North in Twin Falls, Idaho (Figure 1). The site is approximately one-half acre in size and located on the southwest corner of the intersection of Filer Avenue West and Washington Street North within the city limits of Twin Falls, Idaho. The cinderblock building currently on the site was used for dry cleaning operations from the mid 1980s to December 2006 (Figure 2). The site has been vacant from December 2006 to the present.

2.2 Site Use History

From the early 1900s to the 1960s, the site contained a residential house. In the 1960s, the house was torn down and the property remained vacant until the mid 1980s when a cinderblock building was constructed specifically for Mr. A’s Dry Cleaners. The building was used by Mr. A’s Dry Cleaners until December 2006. At that time, the building was vacated in preparation for a Brownfields Assessment and potential sale.

2.3 Hydrology and Groundwater

The area is known for its deep Snake River Canyon, Thousand Springs area, and variable basalt flows. The subsurface basalt flows make for unique and somewhat complex hydrology within the Twin Falls area. Subsurface borings show basalt at an approximate depth of 17 feet below ground surface (bgs) to the east of the site and as deep as 22 feet bgs north and west of the site. Subsurface geology in the area complicates determination of subsurface hydrology, but based upon depth to basalt, the gradient appears to be northwesterly. A borescope analysis conducted as part of the site characterization (TerraGraphics 2007b) found groundwater moving in a west by northwest direction at a rate of 13 ft/day (Figure 3). For detailed information on site hydrology, please refer to the *Site Characterization: Mr. A’s Dry Cleaners 483 Washington Street North Twin Falls ID* (TerraGraphics 2007b).

2.4 Site Characterization

Preliminary soil data from a Limited Level II Site Testing report conducted by EHM Engineers, Inc., in September 2006 indicated the presence of PCE in the soil at the site (EHM 2006).

Region IV Economic Development and the City of Twin Falls completed a Brownfields Assessment application and submitted it to IDEQ for consideration as part of the State of Idaho’s Brownfields Assessment Program. The project was selected and IDEQ contracted TerraGraphics to perform additional groundwater, sub-slab vapor, and soil sampling in order to further characterize contamination at the site. The sampling was primarily conducted to identify the presence of PCE and assess the potential migration of contamination in groundwater and air pathways. The results are reported in the *Phase I Environmental Site Assessment, Mr. A’s Cleaners 483 Washington Street North Twin Falls, Idaho* (TerraGraphics 2007a).

The following assessment was included in the Phase I Environmental Site Assessment (ESA):

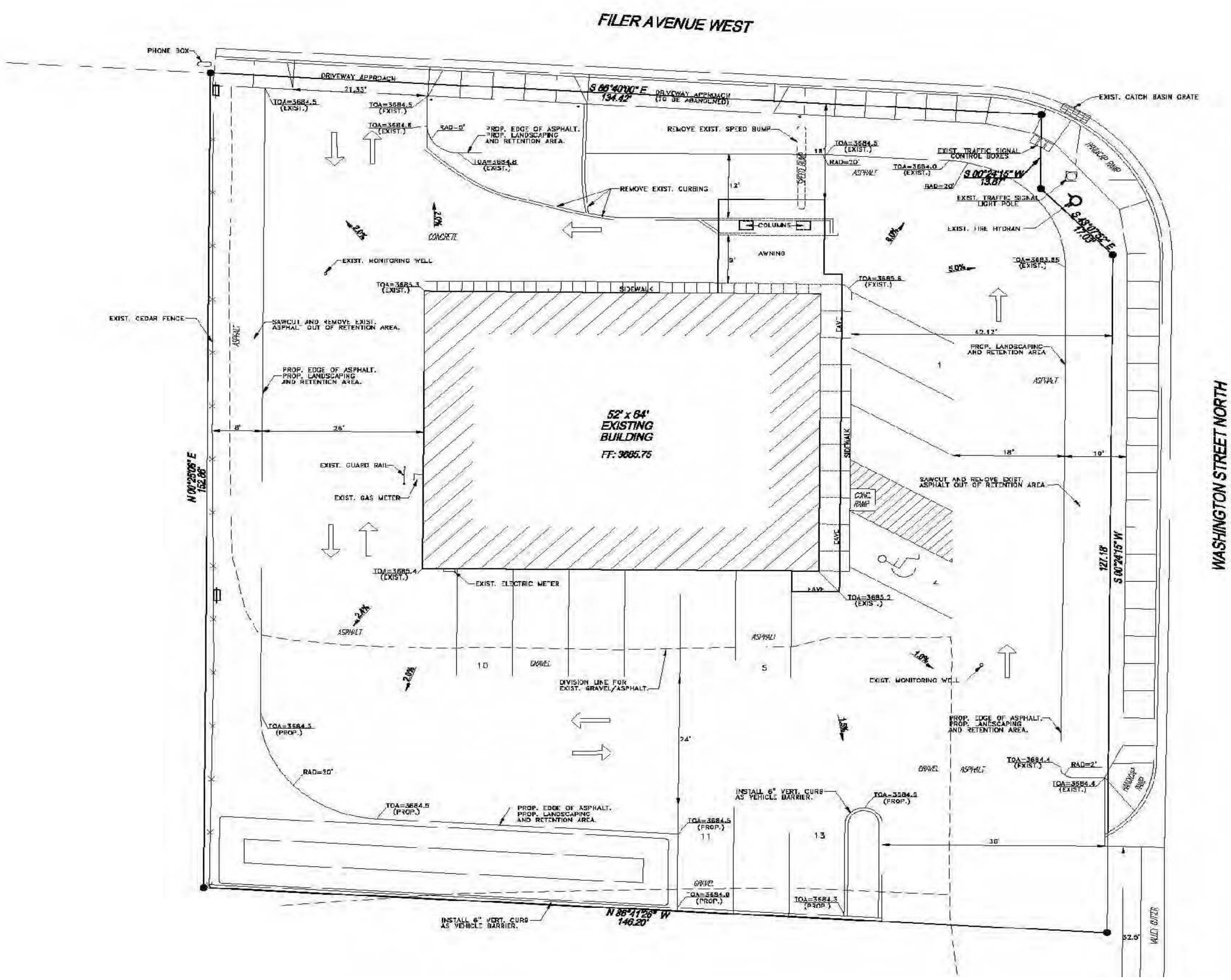
- There is a historic leaking underground storage tank (LUST) site (SuperQuik) upgradient of the site.
- PCE was used on-site as part of the dry cleaning process since the mid 1980s.
- Small stains are present on the boiler room floor.
- Previous subsurface soils sampling confirmed the presence of PCE above IDTLs.

Based on information gathered from historical sources, interviews, site reconnaissance and visual inspection conducted as part of the Phase I ESA, a site characterization to included soil sampling, sampling of existing monitoring wells, vapor sampling, colloidal borescope analysis, and installation of new monitoring wells was recommended and completed in 2007. The objective of this site characterization was to determine if there had been an environmental release to the property from historic dry cleaning operations and to gain a better understanding of site hydrology through measuring groundwater levels and flow patterns.

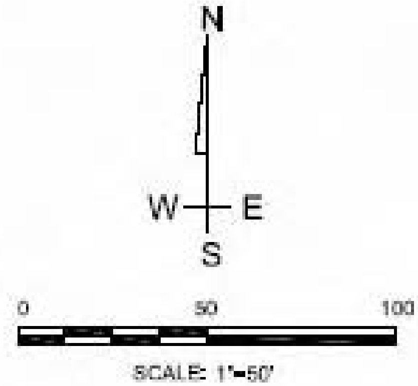
Detailed results from the 2007 site characterization are reported in the *Site Characterization: Mr. A's Dry Cleaners, 483 Washington Street North Twin Falls, ID* (TerraGraphics 2007b) and are summarized below:

- Soil samples collected from both the exterior and interior of the building had PCE concentrations that exceeded IDTLs with a maximum concentration of 1.69 mg/kg. The investigation did not uncover a highly concentrated source area or an area that was obviously the source from a spill and/or significant chronic leak. Soils with PCE above IDTLs were found both under and to the west of the building suggesting the source to originate somewhere within or close to the building.
- Two downgradient groundwater samples had PCE concentrations exceeding IDTLs with the highest concentrations immediately downgradient of the building (187 μg/L); upgradient concentrations were below the IDTLs suggesting the source originates under or near the building.
- Sub-slab vapor concentrations for PCE were detected at concentrations ranging from 8,800 $\mu g/m^3$ to 360,000 $\mu g/m^3$.
- 24-hour ambient air samples collected from the interior of the building exhibited PCE concentrations of 96 $\mu g/m^3$ and 66 μ/m^3, two orders of magnitude above USEPA Region 9 preliminary remediation goals (PRGs) of 0.32 $\mu g/m^3$.

Based upon the 2007 site characterization results, further remedial action is necessary to reduce potential exposure pathways. Identification and comparison of remedial technologies are presented in Section 4.0. This includes technologies for PCE contamination in the groundwater and PCE in the sub-slab (under the concrete floor) vapor.



Project No. 07014	TerraGraphics ENVIRONMENTAL ENGINEERING, INC.	**Mr. A's Cleaners Twin Falls, Idaho**	Date: 5/30/2007
Scale: 24.7' = 1"		**Figure 2. Site Layout**	
Requestor: Jon Munkers			
Drafter: J. Munkers			



Project No. 07158	TerraGraphics ENVIRONMENTAL ENGINEERING, INC.	**Mr. A's Cleaners Twin Falls, Idaho**	Date: 1/2/2008
Scale: 1" = 50'			
Requestor: Jon Munkers		**Figure 3. Groundwater Contour Map**	
Drafter: T. Jones			

SECTION 3.0 CLEANUP GOALS AND OBJECTIVES

The overall cleanup goal for the site is to reduce risks to both human health and the environment. Based on site-specific conditions and reasonably expected future land use (non-residential on-site and residential off-site), the relevant exposure scenario assumptions (actual/potential routes of exposure, exposure pathways and receptors) include the following:

- The current cinderblock building will remain in place,
- On-site exposure to non-residential receptors from PCE vapors volatilized into indoor air from soil, and
- Off-site exposure to residential receptors from groundwater ingestion. (On-site exposure via groundwater ingestion was considered unlikely because the site is provided with water from the City of Twin Falls. Potential off-site use of groundwater exists and is difficult to prevent or control. The regional aquifer in the vicinity of the site has been historically used for domestic purposes and is able to produce adequate amounts of water for those purposes.).

The planned future use for the site property is commercial. A cleaning products retail store has been designed for the existing structure. In keeping with the overall cleanup goal for the site and in accordance with IDAPA 58.01.18, this voluntary remediation work plan submitted for IDEQ approval has identified the remediation standards to attain upon implementation of remedial efforts. The standards, as presented in an IDEQ memorandum, "Summary of Risks and Cleanup Criteria for Mr. A's Cleaners, Washington Street, Twin Falls" (IDEQ 2007), were developed to achieve appropriate health-based levels of the identified contaminants. This was to ensure that substantial present risk or probable future risk to human health and/or the environment is eliminated or reduced to protective levels based upon present and reasonably anticipated future uses of the site (IDAPA 58.01.18(02)b). The standards for the Constituents of Concern (COCs) are identified in Table 1.

Table 1 Target Cleanup Levels

Sample Matrix	Target Concentration (PCE)	Point of Compliance
Groundwater	5 µg/L	Downgradient property boundary or nearest downgradient well
Air vapors	6.9 $\mu g/m^3$	Inside Building
Sub Slab Vapors	23,000 $\mu g/m^3$	Sub-slab vapor well
Soil	Minimize potential for leaching to groundwater.	

SECTION 4.0 IDENTIFICATION OF CLEANUP ALTERNATIVES

The following ABCA was performed to consider a range of reasonable and proven cleanup alternatives, based on contaminant concentrations, site characteristics, surrounding environment, current and proposed land-use, cleanup goals and associated human health risk and potential exposure pathways. This section presents a compilation of potentially applicable technologies for the remediation of the groundwater contaminated with PCE at the former Mr. A's Dry Cleaner in Twin Falls, Idaho. The objective of this technology analysis is to identify technologies to be screened during a thorough evaluation. The criteria used to develop possible alternatives (Section 5.0) are as follows:

- The technology must be applicable to chlorinated solvent remediation in groundwater and the vadose zone, and
- The technology must be feasible to apply for the depth to water and extent of contamination at Mr. A's Dry Cleaners.

Projected costs presented in this section (*Table 2 Comparison of Alternatives,* pages 16-17) are estimates for comparative purposes only. Actual remedial costs could vary significantly.

Seven potentially feasible technologies for implementation at Mr. A's Dry Cleaners were identified (five for groundwater and two for soil vapor). For each of the remediation technologies, a brief description of the technology and a short discussion of advantages and disadvantages of the technology are presented. A summary of the remedy comparison is shown in *Table 2 Comparison of Alternatives*.

4.1 Groundwater Remediation Technologies

Five groundwater remediation technologies were identified and are discussed below. Table 2 illustrates a comparison of the advantages and disadvantages of the five technologies. A cost analysis is also provided in terms of low, medium, and high cost.

4.1.1 In-situ chemical oxidation

Description

In-situ chemical oxidation (ISCO) involves the injection of oxidizing agents into an aquifer for rapid and complete chemical degradation of hazardous organic chemicals of concern. The most commonly employed oxidants include peroxide and permanganate, which are capable of achieving high treatment efficiencies (i.e., >90% for PCE) and fast reaction rates (i.e., 90% degradation in minutes). However, matching the oxidant injected with the contaminant to be degraded is fundamentally important in the design of ISCO systems. The rate and extent of contaminant degradation is dictated by the chemical itself (its susceptibility to oxidative degradation). In addition, site-specific conditions (i.e., pH, temperature, and the concentration of oxidant consuming species such as natural organic matter) also determine the feasibility of this technology for this site.

Advantages and Disadvantages

Advantages of this technology include rapid and significant reduction in contaminant mass when applied correctly. Limitations include the need for accurate characterization of the subsurface for targeted delivery and distribution of the oxidant, the potential for significant decreases in pH, and the potential for reduced permeability (fouling) due to colloid genesis and mobilization of redox-sensitive and exchangeable sorbed metals. Additionally, ISCO is typically applied in source areas for immiscible or sorbed secondary sources rather than for treatment of relatively low-concentration dissolved-phase plumes.

4.1.2 Enhanced in-situ bioremediation

Description

Enhanced *in-situ* bioremediation (EISB) involves the injection of amendments into a contaminant residual source zone or dissolved-phase plume to stimulate native or introduced (i.e., bioaugmentation) microorganisms to degrade organic contaminants. For chlorinated solvents, the primary biological mechanism through which contaminants are degraded is through anaerobic reductive dechlorination (ARD), where contaminants act as electron acceptors during microbial anaerobic metabolism and are converted to reduced forms, such as ethene. The implementation of this technology in aerobic aquifer systems often requires the injection of a carbon and electron source in order to deplete oxygen and drive the conditions within the treatment area towards anaerobic. Once sufficiently reducing conditions are achieved, dehalogenating microbes utilize the contaminants, resulting in hydrogenolysis. In addition, the introduction of an organic substrate can also stimulate reduction of compounds (i.e., iron), resulting in an additional degradation mechanism, beta elimination, within the reaction zone.

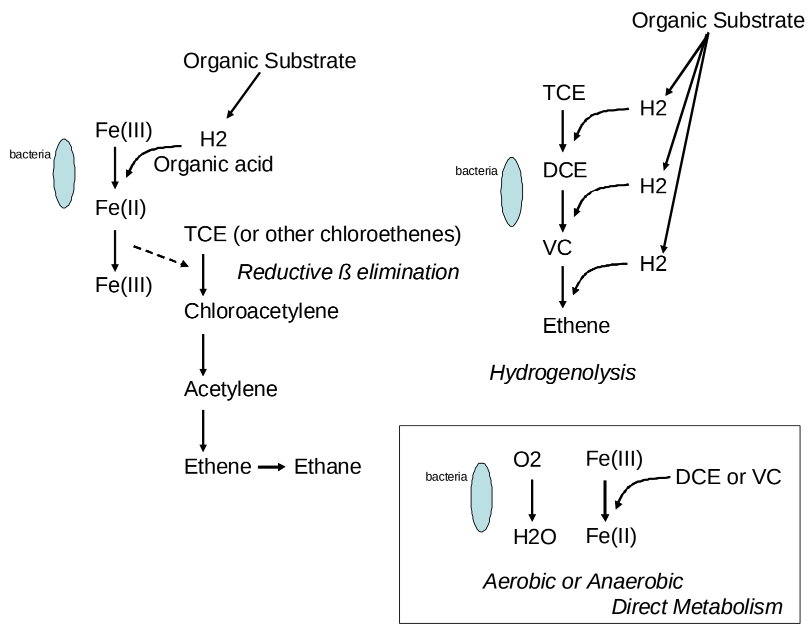
In addition to anaerobic degradation mechanisms, there are also aerobic mechanisms that have been shown to degrade chlorinated solvents. Co-metabolic oxidation involves the fortuitous oxidation of contaminants under aerobic conditions by a broad range of oxygenases (methane, toluene, propane, and benzene). Stimulation of these mechanisms involves the addition of both the primary carbon source (i.e., methane) and oxygen. Numerous amendments are readily available for EISB applications and field tested under a variety of injection designs and hydrogeological settings. Typical radius of influence from injection wells will vary based on the hydrogeology of the site and the physical properties of the amendments, but distribution of electron donor has been observed up to 50 feet from injection wells in fractured basalt aquifers.

Advantages and Disadvantages

Advantages of EISB include relatively fast reaction kinetics (once sufficient biomass is established), and applicability of the technology to a variety of hydrogeologic settings due to the variety of potential amendments that can be used (Figure 4).

Disadvantages of EISB include: 1) the need for accurate characterization of the subsurface for targeted delivery and distribution of the amendment(s), 2) requirement for detailed information on the geochemical and microbiological nature of the treatment area, 3) absence of certain contaminant-degrading microbes at some field sites requires application of contaminant-degrading microbes (bioaugmentation), 4) potential for production of more toxic intermediates, 5) potential odor, and 6) potential changes in groundwater quality (i.e., pH).

FIGURE 4 DEGRADATION MECHANISM



4.1.3 Monitored natural attenuation

Description

Monitored natural attenuation (MNA) utilizes natural subsurface processes such as biodegradation, chemical reactions with subsurface materials, dilution, volatilization, and adsorption for the reduction in contaminant concentrations to acceptable levels. This remediation alternative usually requires modeling and evaluation of contaminant degradation rates and pathways to predict contaminant concentrations at down-gradient receptor points. The primary objective of the modeling is to demonstrate that natural processes will in fact reduce the contaminant concentrations to below regulatory standards or risk based levels before potential exposure pathways are completed. Natural attenuation remedies always include a long-term monitoring program to confirm that attenuation processes are proceeding at rates consistent with meeting cleanup objectives.

Advantages and Disadvantages

Potential advantages of natural attenuation remedies include the limited generation or transfer of remediation wastes, the limited construction of surface structures, and the fact that they can be applied after other (active) remedial measures to all or part of a given site in a total plume remediation strategy. Additionally, the overall cost of this remedy can be lower than active remediation technologies. Potential limitations to natural attenuation remedies include the necessity for long-term monitoring and institutional controls, longer time frames required to meet remedial objectives, and the inherent uncertainty in modeling of the natural attenuation processes that leads to limited confidence regarding the long-term success of the remedy.

4.1.4 Pump and Treat

Description

Pump and treat systems depend on the extraction of groundwater from aquifers, pumping to a treatment center, destruction or removal of contaminants with another technology, and typically re-injection of the treated groundwater or disposal to a treatment facility. Contaminant removal options include technologies such as adsorption/absorption using granular activated carbon (GAC), and air stripping.

Advantages and Disadvantages

General advantages of pump and treat include, 1) hydraulic containment of the aquifer using well designed systems, 2) easier identification of the amount of contaminant mass removed than with *in-situ* technologies, and 3) more treatment options and greater engineering control over the treatment technology.

General disadvantages of pump and treat systems include, 1) the presence of above ground infrastructure, 2) technologies tend to be more expensive than *in-situ* technologies, 3) disposal of treated groundwater and technology specific materials (e.g., GAC) must be arranged, and 4) there is a greater potential for human or environmental exposure to contaminants than using *in-situ* technologies.

4.1.5 Ozone sparging

Description

Ozone sparging is a highly effective remedial technology for treating contaminated soil and groundwater *in-situ*. The process involves injecting high-concentration ozone gas into saturated soils to chemically oxidize VOCs, SVOCs, chlorinated solvents, petroleum hydrocarbons, and other organic compounds. Injected ozone/air traverses horizontally and vertically in channels through the soil column.

A typical ozone sparge system includes a compressed air supply, oxygen concentrator, corona discharge ozone generator, a manifold, and control system. Concentrated ozone gas is directed to the subsurface through a stainless steel manifold using either stainless steel piping or ozone-resistant tubing. Sparge wells are installed throughout the target zone to deliver the ozone gas to the contaminated soil or groundwater. Automatic solenoid valves may be used to cycle the injection of gas through the sparge wells and to automate the process. Portable (trailer mounted) units are also available for pilot tests and/or source remediation.

Advantages and Disadvantages

Potential advantages of ozone sparging include the potential to substantially decrease the mass and concentration of contaminants in a short time period (i.e., weeks or months), and limited generation of remediation wastes. Additionally, when used along with soil vapor extraction (described below), the effluent vapors may not require treatment because the contaminants are destroyed rather than transferred from one phase to another.

Potential limitations to ozone sparging include, 1) soil heterogeneities may cause some zones to be relatively unaffected, 2) injection wells must be designed for site-specific conditions, and 3) a number of sparge points (wells) would be required.

4.2 Sub-Slab Vapor Remediation Technologies

Two technologies were identified for remediation of sub-slab vapor concentrations. The advantages and disadvantages of each are discussed below.

4.2.1 Soil Vapor Extraction

Description

Soil vapor extraction (SVE) is an *in-situ* remedial technology that reduces concentrations of volatile constituents adsorbed to soils in the unsaturated (vadose) zone. In this technology, a vacuum is applied through wells near the source of contamination in the soil. The vapors are drawn toward the extraction wells. Extracted vapor is then treated as necessary (usually with carbon adsorption or catalytic oxidizer) before being released to the atmosphere. Wells may be either vertical or horizontal. SVE may also be appropriate near a building foundation to prevent vapor migration into the building. Here, the primary goal may be to control vapor migration and not necessarily to remediate soil.

Advantages and Disadvantages

Potential advantages of SVE include proven performance, readily available equipment, and easy installation. Potential limitations to SVE include reduced effectiveness when applied to sites with low-permeability soil or stratified soils, concentration reductions greater than about 90% are difficult to achieve, and it may require an air emission permit and treatment of effluent.

4.2.2 Sub-Slab Venting

Description

Sub-slab venting could be used to reduce the concentration of PCE in the former Mr. A’s Dry Cleaner building by pulling PCE vapors from directly under the building slab and exhausting them to the atmosphere.

Advantages and Disadvantages

Potential advantages of sub-slab venting include the ease of implementation and the effectiveness in reducing the risk posed from indoor air PCE concentrations. Potential limitations to sub-slab venting include not addressing the source of the PCE vapor, which in turn would likely require indefinite operation. Venting would also most likely require an air permit for vapor discharge.

Table 2 Comparison of Alternatives

Technology	Applicable Media	Identified Advantages (when evaluated using the performance criteria)	Identified Disadvantages (when evaluated using the performance criteria)	Relative Cost	
				Capital Costs	O&M Costs
In-Situ Chemical Oxidation (ISCO)	Groundwater	• Rapid and significant reduction of contaminant mass. • Minimal site disturbance	• Require installation of injection points (injection wells). • Soil heterogeneity may cause some zones to be relatively unaffected. • Typically more effective for high concentrations (source areas). • Potential for subsurface fouling.	Medium	Low
Enhanced *in-situ* bioremediation (EISB)	Groundwater	• Relatively fast reaction kinetics (once sufficient biomass is established). • Minimal site disturbance	• Accurate characterization of the subsurface required in order to optimize delivery and distribution of the amendment(s) • Requires installation of injection points (injection wells). • Soil heterogeneity may cause some zones to be relatively unaffected. • Requires time to build sufficient biomass for treatment. • Site may require bioaugmentation.	Medium	Medium
Monitored Natural Attenuation (MNA)	Groundwater	• Low cost remedy that is easily implemented. • Minimal site disturbance	• Primarily used as a polishing technique after more active remedies have reduced the contaminant concentration. • Long remedy timeframe.	Low	Medium
Pump and Treat	Groundwater	• Hydraulic containment of plume. • Easier to identify the amount of contaminant mass removed than with *in- situ* technologies.	• Requires aboveground infrastructure for the *ex-situ* treatment of groundwater using technologies such as air stripping or GAC. • Greater potential for human or environmental exposure to contaminants. • Noise	High	High

Technology	Applicable Media	Identified Advantages (when evaluated using the performance criteria)	Identified Disadvantages (when evaluated using the performance criteria)	Relative Cost	
				Capital Costs	O&M Costs
Ozone sparging	Groundwater	• When used in conjunction with SVE potentially could eliminate the need for SVE effluent treatment. • Minimal site disturbance • Potential for substantial decrease in the mass and concentration of contaminants in a short time period.	• Requires installation of sparge points (air injection wells). • Air injection wells must be designed and located based on site-specific conditions. • Soil heterogeneity may cause some areas to be relatively unaffected. • Depth of contaminants and specific site geology must be considered.	High	Medium
Soil Vapor Extraction (SVE)	Soil Vapor	• Addresses the source of the vapor. • Installation could take advantage of the existing piping trenches in the building. • Proven performance; readily available equipment; easy installation.	• Concentration reductions greater than about 90% are difficult to achieve. • Effectiveness less certain when applied to sites with low-permeability soil or stratified soils. • May require an air emission permit. • Effluent may require treatment using technologies such as GAC	Medium	Medium
Sub-slab Venting	Soil Vapor	• Inexpensive and easy to implement • Reduces the risk posed by indoor air concentrations. • Minimal site disturbance.	• Does not address the source of the vapor. • Potentially very long operation time. • An air permit may be required for effluent discharge.	Low	Low

SECTION 5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 Description of Evaluation Criteria

The remedial technologies identified for the site (see Section 4.0) are evaluated in this section based on the following performance criteria: 1) overall protection of human health and the environment, 2) long-term effectiveness, 3) the ability to meet user/owner needs, 4) sustainability, 5) ease to implement, and 6) cost. These performance criteria serve as a basis for conducting a comparative analysis of the proposed remedial alternatives and are described below.

5.1.1 Overall Protection of Human Health and the Environment

This criterion is used to evaluate whether human health and the environment are adequately protected. Human health protection includes reducing risk to acceptable levels, either by reducing contamination concentrations or eliminating potential routes for exposure. Environmental protection includes minimizing or avoiding negative impacts to natural, cultural, and historical resources.

5.1.2 Long-term Effectiveness

This criterion addresses the results of cleanup in terms of risks that remain at the site after cleanup objectives are met. The primary focus of this criterion is to assess the reliability of management controls for providing continued protection from remaining hazards at the site following cleanup.

5.1.3 Sustainability

Sustainability includes an assessment for the potential need to replace the alternative's technical components in the long term.

5.1.4 Ease to Implement

Ease to implement refers to the technical and administrative feasibility of carrying out an alternative and the availability of the required services and materials. The following factors are considered for each alternative:

- The likelihood of technical difficulties in constructing the alternative and delays due to technical problems.
- The potential for regulatory constraints to develop (i.e., as a result of uncovering buried cultural resources or encountering endangered species).
- The availability of necessary equipment, specialists, and provisions, as necessary.

5.1.5 Cost

This criterion considers the cost of implementing an alternative, including capital costs, operation and maintenance costs, and monitoring costs.

5.1.6 Compliance with Applicable Standards

Applicable standards are any appropriate standards, criteria, or limitations under any Federal environmental law or more stringent state requirements that must be either met for any contamination that will remain at the site during or after cleanup or any construction activities that occur during cleanup.

5.2 Detailed Analysis of Alternatives

All of the technologies have the potential to provide for overall protection of human health and the environment and would be designed such that they are in compliance with applicable federal, state, and local codes. Since a No-Action Alternative does not provide for overall protection, and current risks at the site are unacceptable, this alternative was not evaluated. The performance criteria were applied to the alternatives and the results summarized in the table below with a higher total score indicating a more acceptable option.

Table 3 Performance Criteria Summary

	Overall Protection of Human Health and the Environment	Long-term Effectiveness	Sustainability	Ease to Implement	Cost	Compliance with Applicable Standards	Total
Groundwater treatment							
In-situ chemical oxidation	3	2	1	1	2	2	11
Enhanced in-situ bioremediation (EISB)	3	2	1	1	2	2	11
Monitored natural attenuation	0	1	3	3	2	1	10
Pump and Treat	1	1	1	1	1	2	7
Ozone sparging	2	2	2	1	1	2	10
Vapor and source treatment							
Soil Vapor Extraction	3	3	3	2	2	2	15
Sub-Slab Venting	3	1	1	3	3	1	12

Note: (1=low, 2=Medium, 3=High)

SECTION 6.0 PREFERRED ALTERNATIVE

A combination of technologies was selected as the most feasible alternative and is proposed in this cleanup plan for the site. These technologies include groundwater remediation by ozone sparge, and SVE to provide source area remediation (Figure 5). Soil vapor extraction leads in the limited choices available for source area treatment because in addition to being effective for source area treatment, it also will provide indoor vapor remediation. To supplement this treatment, an ozone sparge is selected as a pilot test to spot treat the groundwater and potentially alleviate the need for treatment of SVE vapors. Although ozone sparge, selected as a primary treatment is not economically feasible and offers other disadvantages, it can act as a highly effective spot source treatment and provides opportunities to augment SVE not provided by other technologies. The combination of these two technologies provides the greatest flexibility in the fractured basalt substrate that exists beneath the facility. In addition, the SVE system provides additional vapor removal from the sub-slab that will protect workers within the building.

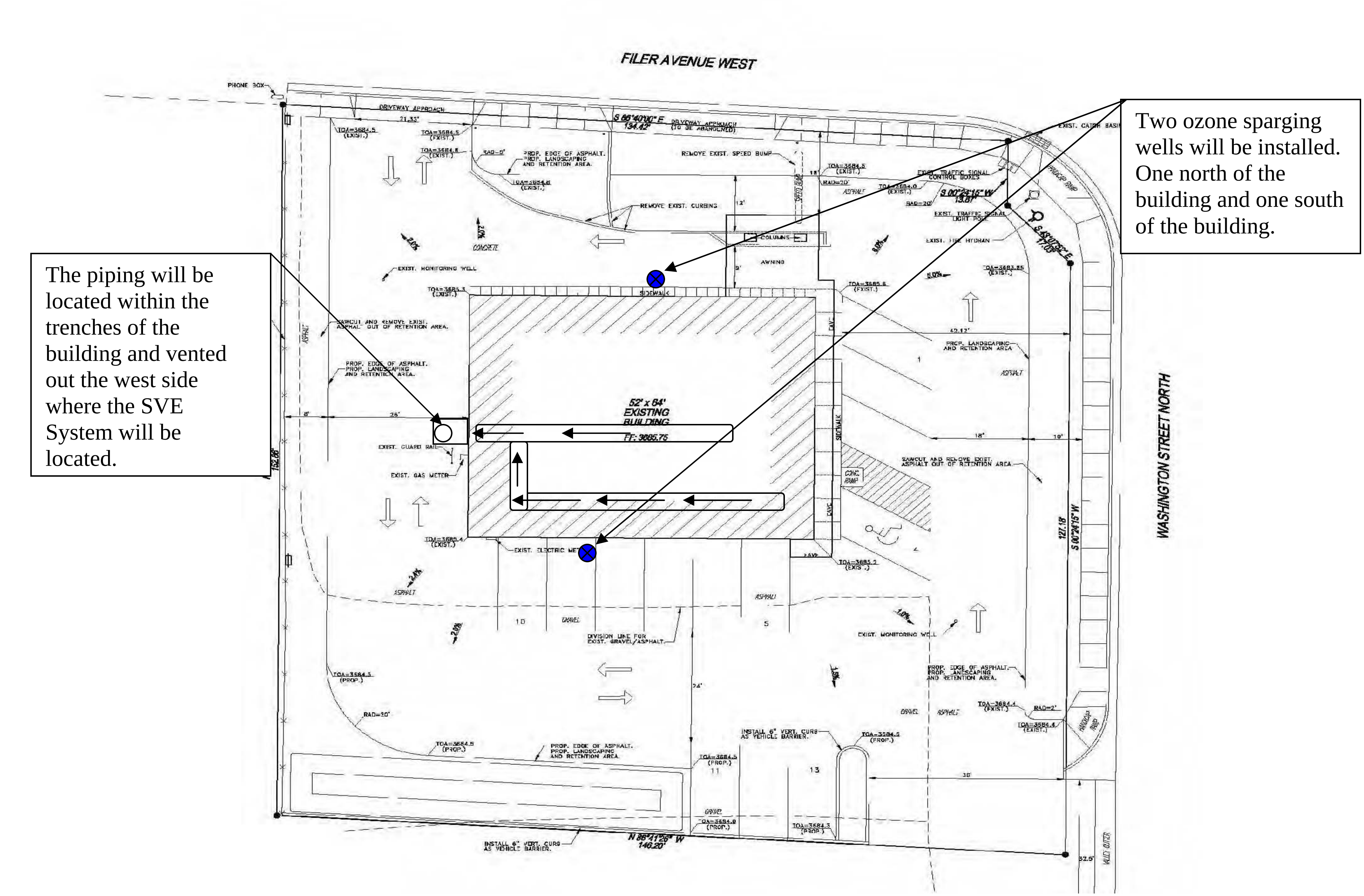
6.1 Soil Vapor Extraction System

A soil vapor extraction system will be installed at the site to reduce concentrations of volatiles in source area soils by drawing the hazardous vapors into subsurface extraction wells. SVE is also an appropriate technology to prevent vapor migration into the building. A skid mounted explosion proof blower with a moisture separator and noise reducing housing will be deployed at the rear of the building with four vertical soil vapor extraction wells installed into the existing trenches within the facility. The vertical extraction wells will extend down into the trenches to varying depths with at least one extending beneath the hardpan layer (approximately 8 feet), one extending to the intermediate zone (above the caliche at approximately 2 to 8 feet) and two wells shallow (to a depth of 1 to 2 feet). Valves that can allow the utilization of the extraction wells in combinations or separately will be built into the design of the system to allow for optimization of the system. A sample port for sampling of effluent vapors will be used to determine the emissions upon startup. Contingencies for the treatment of emissions include adjusting the valves to draw from less contaminated zones or utilization of a influent dilution air valve to minimize emissions, and, if necessary, addition of an online 55 gallon drum of activated carbon to treat the off gases until the concentrations drop to below IDAPA 58.01.01 screening emission levels. Emissions will likely taper as the system operates and it is expected that offgas treatment, if necessary, will not be necessary for a sustained period. Design specifics will be outlined in the SVE design specifications plan that will be prepared and submitted at a later date.

To allow for continued protection of workers within the structure during any SVE system downtime, the planned HVAC system must be properly designed and functioning to both provide thermal comfort and isolate contaminants through pressure control and/or exhaust fans. A technique for eliminating contaminants is to design and operate a heating/cooling system so that pressure relationships between rooms are controlled. This control is accomplished by adjusting the air quantities that are supplied to and removed from each room. If more air is supplied to a room than is exhausted, the excess air leaks out of the space and the room is said to be under positive pressure. If less air is supplied than is exhausted, air is pulled into the space and the room is said to be under negative pressure. Control of pressure relationships can provide the protection to workers that is necessary within the building. The negative pressure under the slab while operating the SVE system will provide worker protection. If the SVE system is offline, adequate positive pressure must be applied to the work areas by the buildings heating and cooling systems or local exhaust must remove contaminants by maintaining negative pressure in the area around the contaminant source. Air will be exhausted to the outdoors. The exhaust system, if used as a contingency system must function in coordination with the rest of the ventilation system. The effectiveness of the heating/cooling system to provide thermal comfort and eliminate risk of contaminants depends upon proper equipment selection, installation, and operation. Further information will be provided during the final design of the SVE system.

6.2 Ozone sparge groundwater treatment

Ozone sparging will be used to the treat contaminated groundwater and contaminants potentially absorbed to the vadose zone materials. Up to three wells will be constructed for the delivery of ozone to the subsurface with monitoring points to check the progress of the treatment. Baseline groundwater samples will be collected at new wells and then ozone will be sparged into the groundwater. Ozone rates will be determined based on comparison to base line concentrations. One ozone treatment is planned that will continue for approximately one month. Performance samples will be collected at intervals during and after the sparging. Results form the sparging will be used to determine if further sparging is necessary and effective.



Project No. 07158	TerraGraphics ENVIRONMENTAL ENGINEERING, INC.	**Mr. A's Cleaners Twin Falls, Idaho**	Date: 1/2/2008
Scale: N.T.S.		**Figure 5. Proposed Remediation System location.**	
Requestor: Jon Munkers			
Drafter: J. Munkers			

SECTION 7.0 MONITORING AND MAINTENANCE OF THE REMEDY

The combination of two technologies (Soil Vapor Extraction and Ozone Sparge) best meets the performance criteria as identified in Section 5.0. The Workplan for implementation of this combination of technologies, including design details, completion milestones, and detailed cost estimates, is described in Section 7.0. TerraGraphics will develop a detailed sampling and monitoring plan, in conjunction with the final design. Consideration will be given to flexibility of the overall system to complement the two remedial components.

7.1 Groundwater Monitoring

Verification of remediation performance will be provided through a groundwater monitoring program. Groundwater will be monitored on a quarterly basis (every three months) for three years. This period may be shortened if monitoring results indicate that the cleanup criteria have been achieved or extended beyond three years if needed to document the completion of the cleanup. Groundwater samples will be collected from the two downgradient monitoring well (known as the Bolton Street Well and FMW-2).

Monitoring wells will be sampled using documented TerraGraphics standard operating procedures. Groundwater samples will be submitted to Anatek Labs of Moscow, Idaho for analysis of volatile organic compounds using EPA Method 8260.

Monitoring reports will be prepared yearly and will include groundwater sample analytical results, groundwater parameters, a brief discussion of field activities, results and figures illustrating site location and groundwater flow direction. The results of each monitoring event will be compared to previous monitoring results and any significant changes will be noted and will also be compared to the IDEQ cleanup criteria. The groundwater monitoring reports will be submitted IDEQ.

Should results stall with no significant further decrease in three subsequent quarters without achieving the site specific remediation goals, an effort will be made to alter the site specific remediation goals through a site specific risk assessment. This request will be presented along with the risk analysis to IDEQ for review and subsequent approval.

7.2 Institutional Controls

The preferred alternative assumes non-residential land use in the area where remediation will take place. Based on this assumption, environmental covenants, recorded as deed restrictions, will be required to restrict land use and activities in this area. If it is determined either during or after the completion of remediation activities that remaining soil and groundwater chemical concentrations are acceptable for unrestricted use, the environmental covenants may be lifted after review and approval by IDEQ of the information submitted to document these conditions.

7.3 Performance Inspections

The SVE system will be inspected periodically for performance. In addition, air samples for calculating source reduction and to ensure compliance with emissions regulations, will be conducted. The details will be provided in the final SVE design plan.

7.4 Design and Construction Phase

A design stage will begin with a site visit by design engineers and field technicians to determine exact locations for all design elements and review site controls issues. An SVE Design Plan containing construction-level designs for all elements, information on the basis of design, and many other identified issues such as property easements, access, biological and hydrological issues, construction wastes, public and worker safety, and site preparation will be issued to IDPR for review. Ozone sparge well placement locations will be identified. Construction will begin once approvals and permits have been obtained.

7.5 Timeline

There are several uncertainties that could cause delays in the proposed timeline. These uncertainties include delays caused by required regulatory review and compliance (i.e., Workplan approval, construction permitting), the availability of materials necessary, and delays caused by weather. The estimated timeline and deliverables schedule is provided in Figure 6.

7.6 Cost estimates

Pre-design costs for each of the remedial elements in a single year are shown in *Table 4 Estimated Project Budget*. These are feasibility level pre-design estimates (+/-50%) and are subject to a number of uncertainties. Actual costs will depend on the final selected design, material costs, local conditions and other factors. Although possible, a more likely case is a multi-year cleanup scenario. Cost estimates are projected through two years.

7.7 Health and Safety Plan

A Safety and Health Plan for the scope of work at the site prepared in compliance with 29 CFR 1910.120 is attached as Appendix A to this workplan. All contractors will perform work in a safe manner, comply with all federal, state and local safety rules and regulations, including, but not limited to, the Occupational Safety and Health Administration (OSHA) Act of 1970. Contractors will provide written documentation that all employees engaged in work at the site have received the OSHA 40 hour Hazardous Waste Operations and Emergency Response (HAZWOPER) Training required under 29 CFR 1910.120, as necessary.

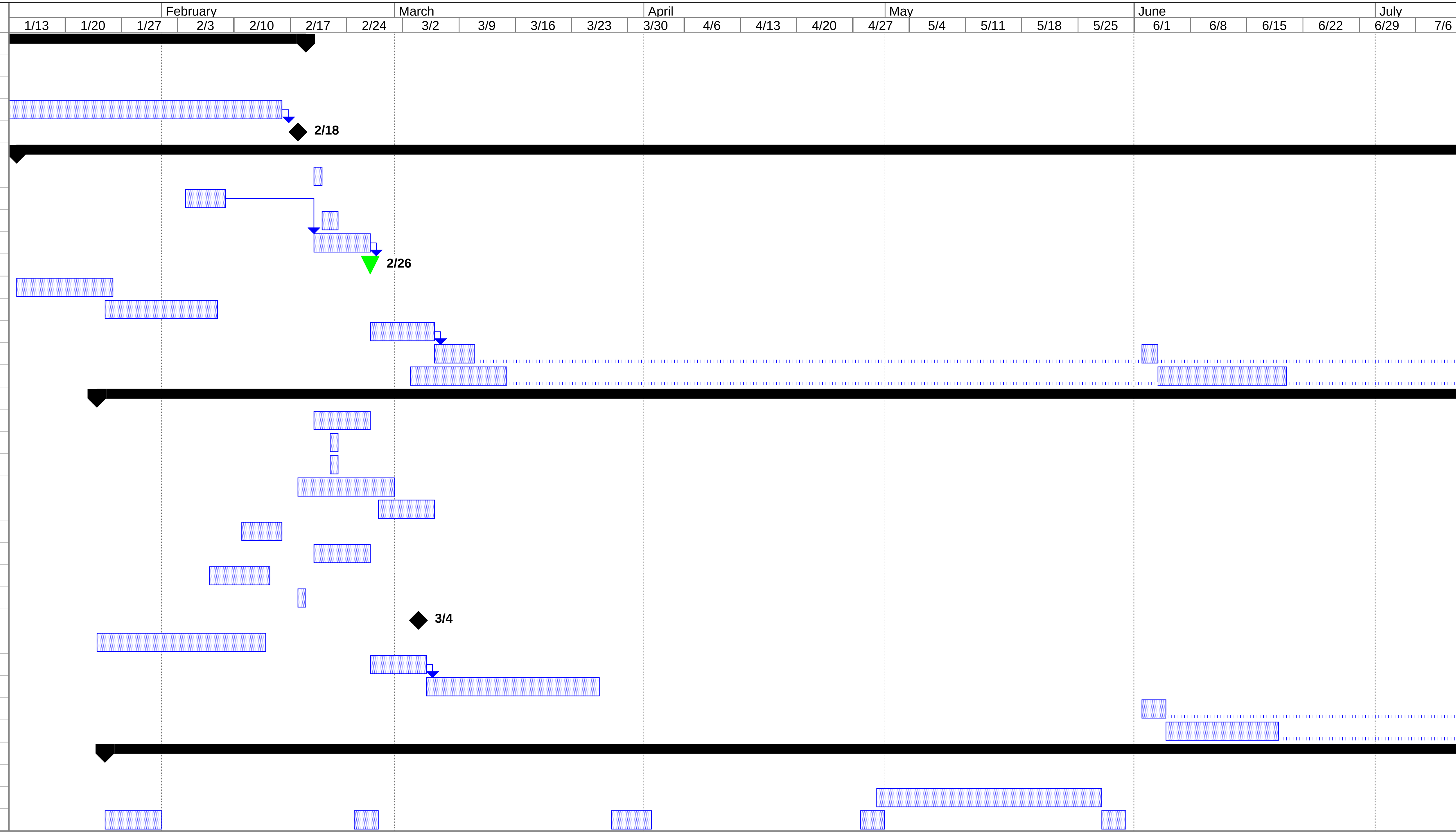
All contractors will have the sole and complete obligation to provide a safe and healthful working environment for their employees and for other persons at the site who may be exposed to the contracted work. All contractors will be required to undertake reasonable efforts to prevent injuries to personnel and will, at all times, maintain all equipment in a safe operating condition.

7.8 Community Involvement Plan

TerraGraphics, in conjunction with the IDEQ, will conduct activities to satisfy the requirements for VCP community involvement for these proposed remedial actions.

Figure 6. Estimated Timeline and Deliverables Schedule.

ID	Task Name
1	**Design and Work Plan**
2	Work Plan
3	IDEQ Review
4	Public Comment Period
5	Approval
6	**SVE Installation/Setup**
7	Install Support Structure
8	Electrical Connections
9	Concrete Work
10	Direct Push Work
11	Installation
12	Process Treatment Procurement
13	SVE Shipping
14	Startup and Testing
15	Analytical Sampling
16	Analytical Analysis
17	**Ozone Characterization**
18	Well Installation
19	Sampling
20	IDW Disposal
21	Sampling/Field Work
22	Ozone Setup
23	Equipment Mob
24	System Setup
25	Electrical
26	Travel
27	Installation
28	Procurement
29	Startup and Testing
30	Analytical
31	Analytical Sampling
32	Analytical Analysis
33	**Reporting**
34	SVE Semi-Annual Report
35	Ozone Pilot Test Report
36	**Monthly Reports**



Project: Mr. A's
Date: Mon 1/7/08

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

Table 4. Estimated Project Budget

	TG Costs	Directs	Fully Loaded Costs
Rate/Hr			
Task Elements			
Task 1. Work Plan			
Meetings	$ 630.44	$ 400.00	$ 1,062.44
Design/Workplan	$ 4,825.35	$ 200.00	$ 5,041.35
Heath and Safety Plan	$ 440.00	$ 200.00	$ 656.00
Sub-Total	$ 5,895.79	$ 800.00	**$ 6,759.79**
Task 2.SVE Setup			
Equipment/System Mob/Demob	$ -	$ 500.00	$ 540.00
Support Structure	$ -		$ -
Knockout water storage	$ -	$ 100.00	$ 108.00
Noise minimization structure	$ -	$ 500.00	$ 540.00
Electrical	$ -	$ 250.00	$ 270.00
Concrete/asphalt cutting and repair	$ -	$ 500.00	$ 540.00
Equipment/Components	$ -		$ -
Construction/installation	$ -		$ -
Equipment	$ -	$ 300.00	$ 324.00
Installation Labor	$ 4,740.00		$ 4,740.00
Direct Push Rig	$ -	$ 2,000.00	$ 2,160.00
Materials	$ -	$ 500.00	$ 540.00
Process/Treatment System Equipt.	$ -		$ -
Process/Treatment System Procurement	$ 810.00		$ 810.00
SVE System shipping	$ -	$ 500.00	$ 540.00
SVE Blower/Controller/system	$ -	$ 1,000.00	$ 1,080.00
Startup and testing	$ 2,160.00		$ 2,160.00
Analytical testing	$ -	$ 1,800.00	$ 1,944.00
Sub-Total	$ 7,710.00	$ 7,950.00	**$ 16,296.00**
Task 3. SVE Operation and Maintenance			
Performance Testing and Analysis	$ 1,731.46		$ 1,731.46
SVE Blower/Controller /System	$ -	$ 11,000.00	$ 11,880.00
Analytical Testing	$ -	$ 2,500.00	$ 2,700.00
O&M Labor and Equipment	$ 660.00	$ 3,000.00	$ 3,900.00
Operation Consumables	$ -	$ 1,200.00	$ 1,296.00
Waste Disposal	$ -	$ 2,400.00	$ 2,592.00
Sub-Total	$ 2,391.46	$ 20,100.00	**$ 24,099.46**
Task 4 Ozone Characterization			
Well Installation	$ -	$ 10,500.00	$ 11,340.00
Sampling	$ 450.00		$ 450.00
IDW Disposal	$ -	$ 4,800.00	$ 5,184.00
Sampling/Field Time	$ 4,350.00		$ 4,350.00
Sub-Total	$ 4,800.00	$ 15,300.00	**$ 21,324.00**
Task 5. Ozone Setup			
Transporation and Setup	$ -		$ -
Equipment/System Mob/Dmob	$ -	$ 3,500.00	$ 3,780.00
System setup	$ -	$ 750.00	$ 810.00
Support Structure	$ -		$ -
Electrical	$ -	$ 250.00	$ 270.00
Equipment and Components/installation	$ -		$ -
Equipment	$ -	$ 300.00	$ 324.00
Travel	$ -	$ 500.00	$ 540.00
Installation Labor	$ 4,200.00		$ 4,200.00
Materials	$ -	$ 500.00	$ 540.00
Process/Treamtne System Equipt.	$ -		$ -
Process/Treatment Procurement	$ 900.00		$ 900.00
Portable ozone injection system	$ -	$ 1,500.00	$ 1,620.00
Startup and Testing	$ 2,640.00		$ 2,640.00
Analytical Testing	$ -	$ 2,000.00	$ 2,160.00
Sub-Total	$ 7,740.00	$ 9,300.00	**$ 17,784.00**
Task 6. Reporting			
SVE Semi-Annual Report	$ 6,222.34	$ 100.00	$ 6,330.34
Ozone Pilot Test Report	$ 5,122.06	$ 100.00	$ 5,230.06
1/4ly project reports	$ -		$ -
Monthly Reportings	$ 5,778.64	$ 100.00	$ 5,886.64
Project Management	$ 9,945.28	$ 100.00	$ 10,053.28
Sub-Total	$ 27,068.32	$ 400.00	**$ 27,500.32**
Project Totals	**$ 55,605.57**	**$ 53,850.00**	**$ 113,763.57**
		Contingency	**$ 11,376.36**
		Total	**$ 125,139.92**

SECTION 8.0 REFERENCES

EHM Engineers. Limited Level II Environmental Site Assessment for Mr. A's Dry Cleaning 483 Washington Street North in Twin Falls, Idaho. September 2006.

Idaho Department of Environmental Quality Risk Evaluation Manual, 1410 North Hilton, Boise, Idaho April 2004.

Idaho Department of Environmental Quality. Memorandum From Bruce Wicherski To Aaron Scheff/Kristi Lowder, Subject: Summary Of Risks And Cleanup Criteria For Mr. A's Cleaners, Washington Street, Twin Falls, October 5, 2007.

IDAPA. Idaho Administrative Procedures Act, 58.01.18 Water Quality Standards.

TerraGraphics 2007a. Phase I Environmental site Assessment, Mr. A's Dry Cleaners, Twin Falls, ID. TerraGraphics, May 2007.

TerraGraphics, 2007b. Site Characterization: Mr. A's Dry Cleaners 483 Washington Street North Twin Falls, ID.